

Irmgard von Broich-Oppert (Head of Sound Archives, RIAS Berlin) and Wilfried Zahn (Chief Engineer, Deutsches Rundfunkarchiv, Frankfurt) presented a joint paper called "*From the Talking Machine to the 'Kunstkopf'*", covering the history of one hundred years from the invention of Edison's phonograph to the latest results of technical progress in the field of sound recording and sound reproduction.

Both talks were illustrated by pictures and by sound recordings, old and contemporary, including the most modern "Kunstkopf" technique. The text of the talks appears directly below.

Dietrich Lotichius, Chairman

ULF SCHARLAU (STUTTGART)

Athanasius Kircher (1601–1680), or Some Aspects of Acoustical Developments in the 17th Century

This year we celebrate the centennial of the invention of sound recording. With this ingenious act Thomas Alva Edison fulfilled an ancient dream of mankind. The thought of listening for example to a record of Xerxes' maledictions when he lost the battle of Salamis, or to the sermons of Jesus Christ, or to the proclamation of Jerusalem's liberation by Bernhard of Clairvaux, or to Martin Luther defending his convictions before Emperor and Reichstag in Worms, or to Beethoven playing his piano sonatas is hardly imaginable. Would it be disappointing if we could hear them today? Who can tell?

One cannot imagine Edison and his invention without the preparatory work of generations of scientists, mathematicians and philosophers before him. Today we shall deal with an epoch which is important for the history of acoustics and therefore also for the pre-history of sound recording: the Baroque, a period in which the idea of divine harmony within world and universe is combined with the new philosophy of rationalism. The most famous representatives of rationalism – René Descartes, Isaac Newton and Gottfried Wilhelm Leibniz – were philosophers, mathematicians and natural scientists at the same time. The work of a contemporary of those three men, the Jesuit Father Athanasius Kircher, was not of equal importance with the other really ingenious men; but just because his work and thinking were not unusual, but typical for his time, he is interesting too. Beyond that Kircher has indeed made some important observations on the acoustical field.

Athanasius Kircher was born in Geisa/Thüringen in 1601. His father Johannes Kircher, who had been a professor of theology, educated his son in music, Latin and geography. When Athanasius was ten years old, he was sent to the Jesuit college in Fulda, where he studied mathematics, Greek and Hebrew. In 1618 Kircher joined the Societas Jesu in Paderborn, and in 1620 his scientific education began in all the subjects which were important for a scholar in those days. At first he studied logics, physics and philosophy, later on continuing with oriental languages. In 1624 he began studying theology in Mainz, where he was ordained a priest in 1628. The following year he became a professor of

mathematics, philosophy and oriental languages at the University of Würzburg. But the Thirty-Years War in Germany forced Kircher to leave his country and undergo exile in France. He had been a professor in Avignon only a short time when he received an order from the Emperor Ferdinand II to come to Vienna as a mathematician of the court. He left Avignon in September 1633 and went to visit Rome first. But when he arrived there in November, he was informed that in the meantime Pope Urban VIII had appointed him to a professorship at the Jesuit's University, the Collegio Romano. The decision was very fortunate for Kircher, because at the time Rome was still the centre of the intellectual world and a place where a scientist like Kircher could receive any financial or other help needed for his work.

From this day Kircher's life became calm and contemplative. When he died in Rome in 1680 he had been living there for 46 years, and had written 32 books; they show his great reputation even by the beautiful way in which the volumes were produced. His voluminous correspondence, still existing today in the archives of the Gregorian University, also gives us an impression of his importance during his life time. Among the authors of these more than 2000 letters are emperors, popes, dukes, cardinals, scientists, musicians and artists.

It is impossible to see Kircher and his time from a modern point of view with regard to his scientific thinking. Kircher and his contemporaries did not specialize in a single subject as they would do today. In the 17th century young men were educated in all subjects and therefore Kircher was later able to write on a variety of topics. He was a polyhistor in the true sense of the word and a characteristic figure of his epoch, in which the universality of knowledge was the basis for all scientific work. Science was then a very clearly-ordered global system of different single subjects which were connected with each other. Therefore for example the integration of theology and philosophy was a clear postulate for the work on natural scientific problems. On the other hand each individual science could only be examined in the context of the whole system. The connecting link of all things are the number, the measure and the quality. "*Numerus est regula et norma omnium*" is one of the Baroque's fundamental axioms. Only those things are true which can be approved by mathematics. Theology too is regulated by this law because the Holy Bible says: "You, my Lord, have regulated all things by measure, number and weight." Spinoza teaches us to comprehend all human beings by the methods of mathematics and gives his book the title: *Ethica ordine geometrico demonstrata*. Descartes creates the analytical geometry which allows us to fix every point clearly and without any doubt.

Kircher's two most important books on natural science are based on these thoughts. His work on optics (*Ars magna lucis et umbrae*) appeared in 1646 and in 1650 he published his *Musurgia universalis sive Ars magna consoni et dissoni*, a large folio book on acoustics and music. Soon the *Musurgia* became very well known, especially in Germany. One reason for this certainly was that a German translation appeared shortly after. From Kircher's point of view music too is regulated by the principle of the number. In his book he describes all sorts of musical questions, for example the origin of sound and its projection, the anatomical structure of the ears, the classification of music, the theory of interval proportions, a theory of composition and counterpoint, and a description of ancient music history and the contemporary as well. (This part of the book is without doubt the most important because of its interesting and very critical remarks on the Italian musical scene of his day, which means especially early opera.) He also describes the connection between music and medical treatment, and writes about all sorts of acoustical phenomena. In the last part of his book Kircher tries to prove that God has created all the world on the numerical basis of the musical proportions. One can see the evident influence of pythagorean philosophy in reading (and I give you the German translation of Kircher's time): „daß die Natur in allen Stücken auf die Music und harmo-

nische Proportionen gesehen habe, sogar, daß die ganze Welt nichts anderster zu seyn scheint, als ein vollkommene Music und musicalische Harmony". With an allegory already used by Johannes Kepler, Kircher paints a picture of the world as a great organ which is built and played by God the Father Himself.

During classical antiquity the wave propagation of sound was already known. But it is interesting that during the entire Middle Ages no further explorations on acoustics were undertaken. Galileo Galilei was the first to again refer to the antique tradition when in his *Discorsi* of 1638 he made systematic experiments concerning the dependence of sound level on the length, thickness and tension of strings. Galilei and Marin Mersenne (a well known colleague of Kircher) had already correctly noticed that the pitch of sound is determined by the vibration frequency within equal time intervals. It is clear that Kircher's own acoustical experiments dealt with a subject in which many of his contemporaries were deeply interested. Many details in the *Musurgia* inform us about those experiments. Mainly problems of reflection and diffusion of sound seemed to be most important to him. We read about experiments in the castle of Heidelberg, in the Mainz cathedral between 1624–28, outside the city walls of Avignon and Rome and finally in St. Peter where Kircher was especially interested in the acoustical problems of the extremely large cupola. Let me try to sum up his results (which in part were proven also by other scientists working at the same time).

For Athanasius Kircher sound originates from a collision of solid matter which at the same time causes a motion of the air. This motion touches the ear and from the ear it is lead to your intellect, where it is decided whether you find this noise or sound pleasant. Kircher correctly recognized the correspondence between the number of air vibrations and the number of impulses on your ear. He also discerned that sound waves can cause motion which is visible. So for example the strings of a harp can start to play by themselves if another instrument in the orchestra causes a similar vibration. This phenomenon Kircher calls "*Sympathia*". The rules of "*Sympathia et Antipathia Rerum*", the fundamental principles of magnetism, are one of the most interesting scientific and philosophical themes of the Baroque. One can see also that Kircher is making a first unconscious step towards sound recording.

Of great later importance were Kircher's experiments to recognize the principles of the velocity of sound and sound reflections. For example he tried to measure the velocity of sound by counting his own pulse from the moment when he saw the flash of a gun's shot until he heard its sound. Making use of this method he figured out the proportion between the distance which sound has to travel and the time it takes. At the same time Kircher noticed the independence of the velocity of sound from the pitch of a note; this he discovered when he shot a gun and a pistol at the same moment. Also of importance are Kircher's results in exploring the similarity of light and sound waves. He also writes about the echo and its practical use in the music of his days. Here we are reminded of the old tradition of echo choirs especially in Venice by Marenzio, Gabrieli, Vecchi, Palestrina, de Kerle or Monteverdi. Kircher tells of a performance which took place in the cupola of St. Peter in Rome, where only one person was singing, although listeners heard a complete canon of four voices, a result of the echo effect of this building.

Finally I want to point to Kircher's experiments in amplifying sound, and the advantage of his results for the construction of a sort of early secret listening device, which was undoubtedly very interesting for Italian aristocrats. The amplification of sound was of course also important for the construction of good theatres and concert halls.

Kircher's book is full of pictures, examples and digressions. Thus for example he reflects on the character of the music played before the walls of Jericho. Kircher is convinced that the walls must have fallen because of the great vibration of air caused by the absolutely horrible trumpet music and soldiers' battle cry, which the bible reports.

Kircher expects the same effect to take place when the trumpets of the last judgement blow and the graves will open. He also writes of having tried one day to conserve a tone being blown into a pot which had been closed immediately afterwards. Kircher regrets very much that this method of sound conservation was not successful. The story probably reminds you of the fairy tale of Münchhausen, who tried to play his trumpet on a cold winter day. But the tone had been frozen in the instrument. Later when he was back in the warm house the tone came out without his touching the instrument: it had defrosted. For Münchhausen it is a story of lies, but for Kircher it was a true scientific experiment.

We should also mention the many musical boxes and automatons Kircher constructed. This technique based on cylinders with iron projections or holes, was really a method of recording sound and reproducing it by the construction of such machines. Succeeding generations went further than Kircher, and some of them used the *Musurgia*. Think too of the compositions "*für eine Flötenuhr*" by Joseph Haydn, or Beethoven's music for an orchestron. The climax of this development is the Welte "Mignon" Piano which is really nothing else but such a machine.

It is entirely proper that Edison's invention should be celebrated this year. We should not however forget the pre-history of his invention. Some of his predecessors had already had similar ideas a few hundred years earlier. But they lacked the technical means and know-how. Leonardo da Vinci constructed a helicopter on paper — it did not fly until 400 years later. Some of Kircher's ideas may today seem rather naïve and sometimes even ridiculous, but we should always try to understand his intellectual background. Admiring the thoughts and inventions of a genius like Edison, we should never forget the pioneering work of his forerunners.

Athanasius Kircher (1601–1680), un père jésuite allemand, théologue, mathématicien, physicien et linguiste ayant passé la majeure partie de sa vie à Rome, est le type caractéristique du savant de la période baroque. Les mathématiques, et surtout le nombre sont pour lui la base de toute recherche et la pierre de touche de la vérité. Dans son livre *Musurgia universalis* (Rome, 1650) tous les problèmes et tous les phénomènes de la musique ont été décrits. Tout ceci a indirectement influencé la fixation sonore. En plus il construisit des boîtes à musique avec cylindre, une forme d'enregistrement musical qui devance de 200 ans la découverte d'Edison.

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Athanasius Kircher (1601–1680), ein deutscher Jesuitenpater, Theologe, Mathematiker, Physiker und Sprachgelehrter, der den größten Teil seines Lebens in Rom verbrachte, ist der für das Barockzeitalter charakteristische Typus des Wissenschaftlers. Die Mathematik, vor allem die Zahl, gilt ihm als Grundlage aller Forschung und Prüfstein der Wahrheit. („*Numerus est regula et norma omnium.*“) In seinem Buch *Musurgia universalis* (Rom 1650) werden alle musikalischen Probleme und Erscheinungsformen beschrieben. Darunter sind ausführliche Berechnungen und Experimente über akustische Phänomene wie Schallausbreitung, Reflexion und Schallgeschwindigkeit, die indirekt für die Erfindung der Schallaufzeichnung von Bedeutung wurden. Daneben konstruierte er Musikautomaten mit Stiftpfeifen, eine Art Tonträger, mehr als 200 Jahre vor Edisons Erfindung.